ELIMINATION OF ROCKET IGNITION SIDE LOADS, Phase I Project

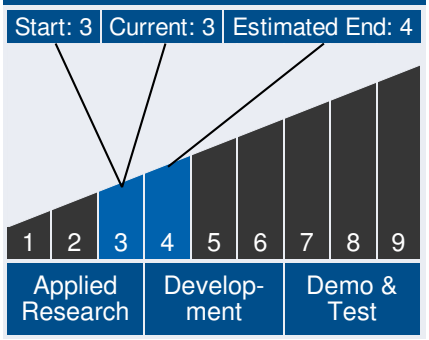
SBIR/STTR Programs | Space Technology Mission Directorate (STMD)

ABSTRACT

This proposal is responsive to Topic H10: Ground Processing and in particular to Subtopic H10.02. When a rocket motor/engine is ignited at low altitude its convergent/divergent nozzle experiences significant impulses across the nozzle; these impulses are known as "ignition side loads" (ISL). The ISL duration ranges from a few tenths of a second for small nozzles, to as long as several seconds for very large nozzles. These large-amplitude ISLs are transient, chaotic, and develop during the chamber pressure rise when the over-expanded nozzle is partially empty. The ISL peak amplitude in large rockets can be as high as 70% of the nominal thrust. The ISL has caused problems in most rocket engine development programs, from pulling off engines from gimbals during their testing, to causing cooling engine lines cracks, knocking off instrumentation, and a large variety of other ISL related issues. ISLs are also experienced during hot staging of launchers and missiles. The current models for predicting ISLs result in very conservative estimates for the TVC actuators and nozzle throat structures, and impact negatively on development schedule, cost, and engine weight. The proposed work for Phase I will demonstrate the feasibility of eliminating for the first time the ISL by developing a set of methods and procedures that will show by CFD simulation how to effectively reduce the ISL to a negligible level. The innovation consists of a set of devices installed precisely within the nozzle that stabilize the flow during the start up pressure rise and thus eliminate the ISL. These inserts are present ONLY during the brief period of rocket ignition and chamber pressure ramp-up. Once the rocket chamber reaches the nominal pressure in a short time, they ablate away and the nozzle configuration geometry returns to the intended high performance design. By implementing this innovation, the ISL risk is eliminated altogether, thus greatly simplifying engine/motor development.

Table of Contents

Technology Maturity



Management Team

Program Executives:

- Joseph Grant
- Laguduva Kubendran

Program Manager:

- Carlos Torrez

Continued on following page.

ELIMINATION OF ROCKET IGNITION SIDE LOADS, Phase I Project

ANTICIPATED BENEFITS

To NASA funded missions:

Potential NASA Commercial Applications: This program has been organized assuming that the first user of this technology will be solid rocket motor boosters and engines used in a launcher such as Orion, but its results can be applied without much additional effort to other liquid propellant engines and motors they are ignited at low altitude from Earth. ASEG has already probed the market and the interest of aerospace agencies in eliminating the ignition SL, and has had a very favorable response. This program has been organized assuming that the first user of this technology will be in NASA engines, but its results can be applied without much additional effort to other liquid propellant engines, as well as solid rocket motor boosters. During the feasibility demonstration Phase I, Government agencies and propulsion prime contractors will be approached to brief them on the technology under development and the on-going results. A potential partner will be identified to join the program in Phase II, when the tools for the design and implantation of the inserts will be developed and tested in the simulator. In Phase III, the industrial partner will assist ASEG in testing the technology as a piggy back to an on-going engine development program. This industrial partner could be hopefully a NASA testing facility, a prime, or a combination of both. An agreement between Phase III partner and ASEG will be arranged for design of the inserts, their fabrication, and licensing to other industrial firms.

To the commercial space industry:

Potential Non-NASA Commercial Applications: Commercial Sector Elimination of SLs on launch vehicles. The SL elimination devices can be retrofit. They can be installed on boosters, as well as on launchers using cryogenic propellants. This will result in lighter structures used in the throat and TVC actuators. The results and products of this proposal are of interest to the Air Force, US Navy, US Army, Orbital/ATK, Aerojet,

Management Team *(cont.)*

Principal Investigator:

- Jose Chirivella

Technology Areas

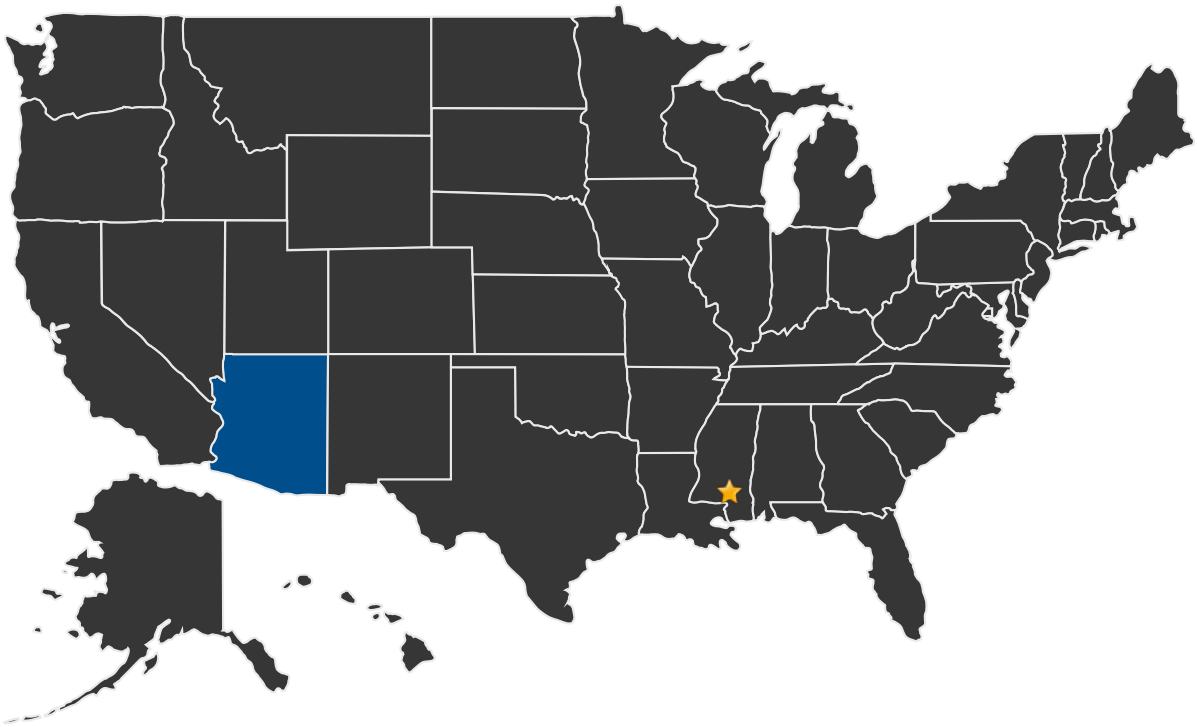
Primary Technology Area:

Launch Propulsion Systems (TA 1)

- Liquid Rocket Propulsion Systems (TA 1.2)
  - Fundamental Liquid Propulsion Technologies (TA 1.2.6)

Northrop/Grumman, Lockheed/Martin, and Raytheon. These agencies and industries have had to contend with ignition SLs in the past 10 years. Defense Applications - Strategic missile defense: Elimination of SLs during staging of strategic missiles, and interceptors - Elimination of ignition side-load in tube launched tactical missiles when egression is assisted by a gas generator to protect operating personnel - The results of this three Phase effort can be applied to any boosters, liquid engines, used in launchers, as well as those missiles that use hot staging to improve the time-of-flight. This applies to new launchers and missiles, as well to the existing fleet of vehicles with residual issues on ignition SLs by application of trivial retrofit programs. - Missiles that are tube-launched by a gas generator and are ignited after egression at a safe distance to protect the personnel (Javelin system). Estimates of the disturbing SL in a hot staging of the first stage of missiles, such as the SM-3 family

U.S. WORK LOCATIONS AND KEY PARTNERS



U.S. States With Work

Lead Center:
Stennis Space Center

Other Organizations Performing Work:

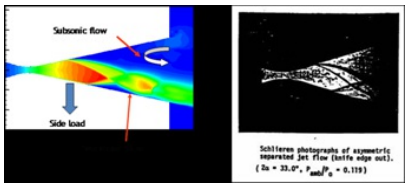
- Arizona Systems Engineering Group, LLC. (Tucson, AZ)

PROJECT LIBRARY

Presentations

- Briefing Chart
  - (http://techport.nasa.gov:80/file/23454)

IMAGE GALLERY



ELIMINATION OF ROCKET IGNITION SIDE LOADS, Phase I

DETAILS FOR TECHNOLOGY 1

Technology Title

ELIMINATION OF ROCKET IGNITION SIDE LOADS, Phase I

Potential Applications

This program has been organized assuming that the first user of this technology will be solid rocket motor boosters and engines used in a launcher such as Orion, but its results can be applied without much additional effort to other liquid propellant engines and motors they are ignited at low altitude from Earth. ASEG has already probed the market and the interest of aerospace agencies in eliminating the ignition SL, and has had a very favorable response. This program has been organized assuming that the first user of this technology will be in NASA engines, but its results can be applied without much additional effort to other liquid propellant engines, as well as solid rocket motor boosters. During the feasibility demonstration Phase I, Government agencies and propulsion prime contractors will be approached to brief them on the technology under development and the on-going results. A potential partner will be identified to join the program in Phase II, when the tools for the design and implantation of the inserts will be developed and tested in the simulator. In Phase III, the industrial partner will assist ASEG in testing the technology as a piggy back to an on-going engine development program. This industrial partner could be hopefully

a NASA testing facility, a prime, or a combination of both. An agreement between Phase III partner and ASEG will be arranged for design of the inserts, their fabrication, and licensing to other industrial firms.